

# CULVERT MAINTENANCE



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## Culvert Maintenance

- Similar to bridges
  - approach road
  - channel
- Structurally different
  - upstream end
  - downstream end
  - barrel



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## Maintenance Recommendations

Maintenance Recommendations						
Work Type	Status	Rec. Year	Target Year	Inspector Comments	Department Comments	
PLACE ADDITIONAL RIP RAP						
REMOVE DRIFT ACCUMULATION						

- CUL1, CULM and CULE form recommendations are identical



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## Maintenance Recommendations

Maintenance Recommendations						
Work Type	Status	Rec. Year	Target Year	Inspector Comments	Department Comments	
PLACE ADDITIONAL RIP RAP		2017		25m <sup>3</sup> Cl. 1 at inlet		
REMOVE DRIFT ACCUMULATION		2017		At outlet		
Install Storms		2017		T.T. Storms in R1-R6		
Concrete Floor		2017		Full length		
Other Action		2017		Install delineators along with shoulders		

Structural Condition Rating (Last/Now) / Sufficiency Rating (Last/Now) (%) Est. Repl. Yr: 2025 Maint. Req'd. (Y/N) Yes

- CUL1, CULM, CULE form recommendations are identical



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## Approach Road Maintenance

- Embankment
  - slides, slumps, etc.
    - repair by removing failed material & replacement with competent, compacted material
  - remaining items same as for bridges

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## Upstream / Downstream End Maintenance

- Upstream & Downstream ends have the same inspection items
- Head Wall
  - usually a low maintenance item
  - broken, spalled concrete
    - patch
  - scaled concrete
    - repair & seal (when salt applied to roads)

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## Upstream / Downstream End Maintenance (Cont'd)

- Collar / Concrete Slope Protection
  - scoured / eroded
    - compacted fill and rock riprap
  - settled & broken
    - replace with fill and riprap

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## Adding end treatment to existing culvert.



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## Upstream / Downstream End Maintenance (Cont'd)

- Wingwalls
  - deteriorated concrete
    - chip out and replace
  - separated from barrel
    - re-connect with steel plates
    - fill gap with flexible material
  - pushing inwards
    - strut between

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## Damaged floor at outlet transition.



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## Horizontal Steel Strut



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## Upstream / Downstream End Maintenance (Cont'd)

- Cutoff Wall
  - usually buried if present
  - if not present and a problem with piping
    - Install cut off wall
    - Install sand/cement filled bags

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**Cement / sand filled bags to repair inlet piping**



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**Adding cement / sand filled bags to inlet**



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**Adding cut-off wall to existing culvert.**



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**Wash out due to piping  
(Brewster Creek Sunchild Road)**



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## Upstream / Downstream End Maintenance (Cont'd)

- Bevel End
  - excessive heaving
    - remove and reset with end treatment
    - replace with new end treatment
  - folding in
    - add collar
    - strut
  - current end treatment requirements are:
    - 1.5 to 3.0m      special conditions
    - 3.0 to 4.5m      upstream end only
    - >4.5m      both ends

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## Bevel pushing inward – repaired with horizontal strut



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## Heaved inlet on SPCSP culvert.



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## Upstream / Downstream End Maintenance (Cont'd)

- Scour Protection
  - Erosion / scour
    - add suitable size rock riprap with filter cloth to apron and/or around collar or bevel
- Scour / Erosion
  - scour / erosion
    - add rock riprap with filter cloth to suit velocities anticipated

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### High velocity at outlet during high water

(Bald Mountain Hwy 40)



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### Extreme turbulence at outlet.



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### Downstream bed erosion and bank erosion at bend.

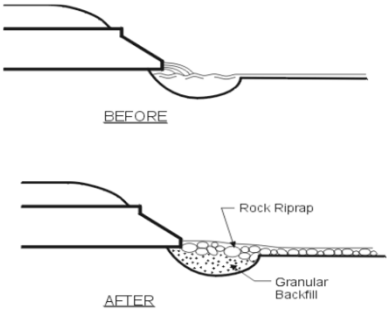


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### Downstream Apron Repair



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## Upstream / Downstream End Maintenance (Cont'd)

- Rock Riprap Material Size versus Stream Velocity

Riprap Class		Allowable Velocity
Class 1m	-	2.0 m / sec
Class 1	-	3.0 m / sec
Class 2	-	4.0 m / sec
Class 3	-	4.7 m / sec

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## Upstream / Downstream End Maintenance (Cont'd)

- Degradation
  - restore stream bed elevation
  - add material
  -
- Aggradation
  - restore stream bed elevation
  - remove material

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## Stream degradation and scour hole.



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## Hanging outlet due to degradation and scour.



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Typical scour and degradation at outlet



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New rip rap added to bevel and apron



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Streambed aggradation (Cougar Creek Canmore).



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Restored inlet



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## Barrel Maintenance

- Roof
  - Sagging 15% or more
  - Reverse curvature
    - add struts (might be too late for liner due to reduced hydraulic capacity).

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## Reverse curvature in roof



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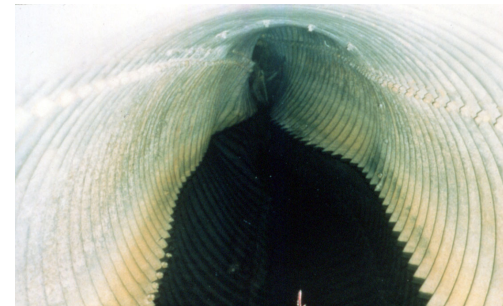
## Barrel Maintenance

- Sidewall
  - deflecting
    - add struts (or install liner if adequate capacity)
  - corroded
    - Install liner
    - cathodic protection (not as common as previously)

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## Failed SPCSP culvert (inadequate backfill).



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## Soil side corrosion, perforated side wall.



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## Barrel Maintenance

- Floor
  - bulging
    - Place U/S cut-off wall if piping
    - add struts or install liner
  - corroding
    - cast concrete floor
    - cathodic protection

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## Severe Floor perforations



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## Floor perforations repaired with concrete floor



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Arch shaped CSP with heaved floor and deflecting roof.



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Strutted barrel



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Concrete arch culvert with curved wingwalls in Feb. (Weed Creek)



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Arch culvert after high water in July.



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### Culvert outlet after high water.



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### Inlet of new culvert, following winter.



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### Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event and drift blockage – Showing Outlet



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### Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event – Inlet blocked by drift



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### Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event



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### Hwy. 40 Lineham Creek – Replacement with 8-14-8M SLW girders in 2015



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### Table 11.1 Maintenance Work Types – Culverts & Bridges

LEVEL 1 INSPECTION	CORE TIMBER CAPS/CORBELS
CONCRETE DECK INSPECTION	REPAIR/REPLACE TIMBER CAPS
CONCRETE GIRDER INSPECTION	REPAIR ABUTMENT SCOUR/EROSION
VERTICAL CLEARANCE MEASUREMENT	PLACE ADDITIONAL RIP RAP
CHLORIDE TESTING	REMOVE DRIFT ACCUMULATION
COPPER SULPHATE ELECTRODE TESTING	INSTALL CATHODIC PROTECTION
PAINT INSPECTION	INSTALL CONCRETE/STEEL LINING
STEEL CULVERT BARREL MEASUREMENT	INSTALL STRUTS
SPECIAL STRUCTURE MONITOR	INSTALL CONCRETE COLLAR/CUTOFF
ULTRASONIC TRUSS INSPECTION	REPAIR SEAMS
SCOUR SURVEY INSPECTION	OBTAIN CORROSION ANALYSIS DATA
REPAIR/REPLACE BRIDGERAIL	REPAIR/REPLACE SIGNING
GALVANIZE/PAINT BRIDGERAIL	PATCH/REPAIR ACCESS PLATFORM
RETROFIT BRIDGERAIL	ADJUST/PAINT PEDESTAL BEARING AREA
SEAL CURBS	OTHER ACTION
PATCH DECK	REPAIR/REPLACE TIMBER CORBELS
SEAL DECK	REPAIR/REPLACE TIMBER PILES
OVERLAY DECK	LOAD POST BRIDGE
REPAIR/REPLACE DECK JOINTS	REPLACE MEMBERS
REPLACE STRIP DECK	STRAIGHTEN MEMBERS
REPLACE SUB DECK	REPAIR MEMBERS
RESET/PAINT BEARINGS	INSTALL BOLTS
REPAINT SUPERSTRUCTURE	REPAIR BEARINGS
STRAIGHTEN/REPLACE MEMBERS	CRACK REPAIRS/TREATMENT
WASHING	PATCH CURBS/PARAPETS
FILL BOLT HOLES	REPAIR STRUTS
SHOTCRETE REPAIRS	REPLACE CULVERT

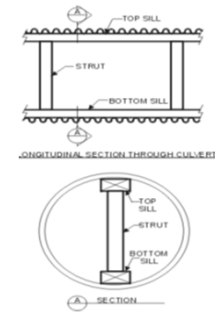
Table 11.1 – Maintenance work types

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### Timber Strutting of Metal Culverts

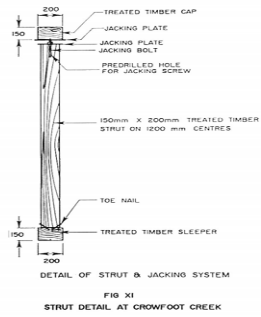


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### Strut detail (Crowfoot Creek Hwy 1).

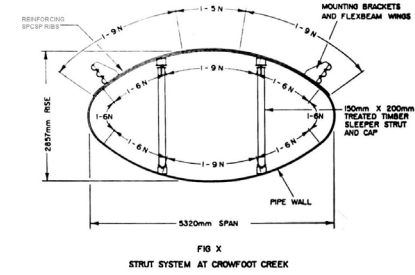


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### Strutting arrangement for a horizontal ellipse.



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### Completed installation of adjustable struts

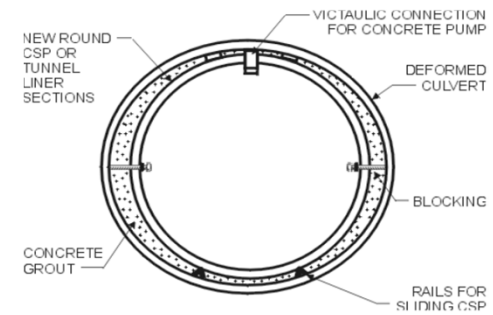


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### Culvert Liners



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**Installing a CSP liner.**

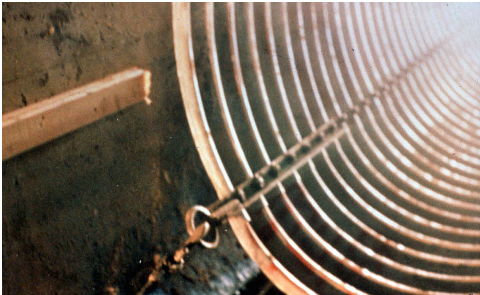


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**SPCSP liner is assembled outside and then pulled into an existing culvert.**

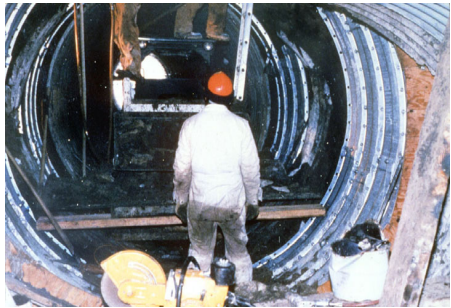


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**For larger culverts, tunnel liner plates are used.**



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**Liner installed ready for grouting.**



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## Barrel Maintenance

- Circumferential Seams
  - separated
    - inject concrete or grout
    - Install inside coupler plates
- Longitudinal Seams
  - cracked
    - monitor
    - shotcrete reinforcement
    - cast 1/2 arc concrete
    - install liner

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## Properly lapped seam.

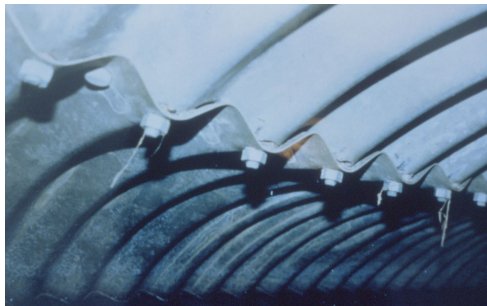


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## Incorrectly lapped seam with poor nesting



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## Incorrectly lapped seam with cracks



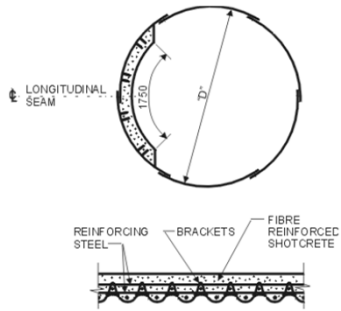
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### Longitudinal Seam Reinforcing



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### Reinforcing and shear connectors fastened to culvert.

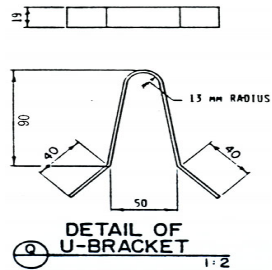


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### Shear connector detail.



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### Shear connectors and rebar in place over cracked seam.



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### Applying the shotcrete.



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### Completed shotcrete reinforcing beams.



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### Bottom reinforcement for arch shaped culvert. (Nose Creek Hwy 2)

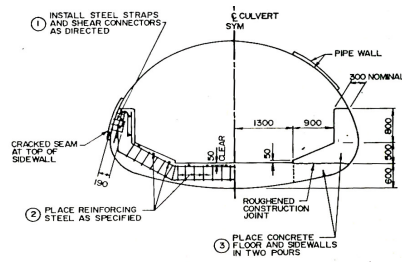


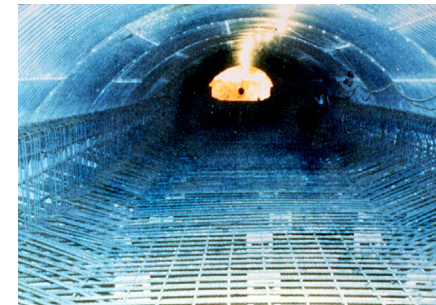
FIG. XII

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### Reinforcing installed for arch culvert reinforcement.



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## Floor cast inside arch culvert.



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## Barrel Maintenance

- Coating
  - Corrosion
    - Soil side corrosion
    - Liner
  - Water side corrosion
    - Concrete floor
    - Liner

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## Barrel Maintenance (Cont'd)

- Fish Passage Adequacy
  - add baffles
    - cast concrete
    - rocks
    - weir type
  - repair / build downstream apron
- Waterway Adequacy
  - install additional culvert (jacking)
  - remove drift or silt
  - install stream lining

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## Channel Maintenance

- Similar to bridges - Degradation (scour), Aggrading
- Drift more of a concern
- Beavers are common
- High velocities at outlet

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**Drift collected at inlet**



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**Drift in strutted barrel – 100% blockage**



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**Questions?**



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